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(71) Applicant: LG ELECTRONICS INC. [KR/KR]; 20, Yoido-dong, Youngdungpo-gu, 150-010 Seoul (KR).

(72) Inventors: PARK, Kyung Chan; 75-201, Hyundai Apt., Apgujung-dong, Kangnam-gu, 135-110 Seoul (KR). KIM, Young Kuk; C-502 LG Kisooksa, 19-1 Chungho-ri, Jinwee-myun, Pyungtaekl-si, Kyunggi-do 451-862 (KR).

(74) Agent: PARK, Lae Bong; 1Fl., Dongun Bldg., 413-4, Dogok 2-dong, Kangnam-gu, Seoul 135-272 (KR).

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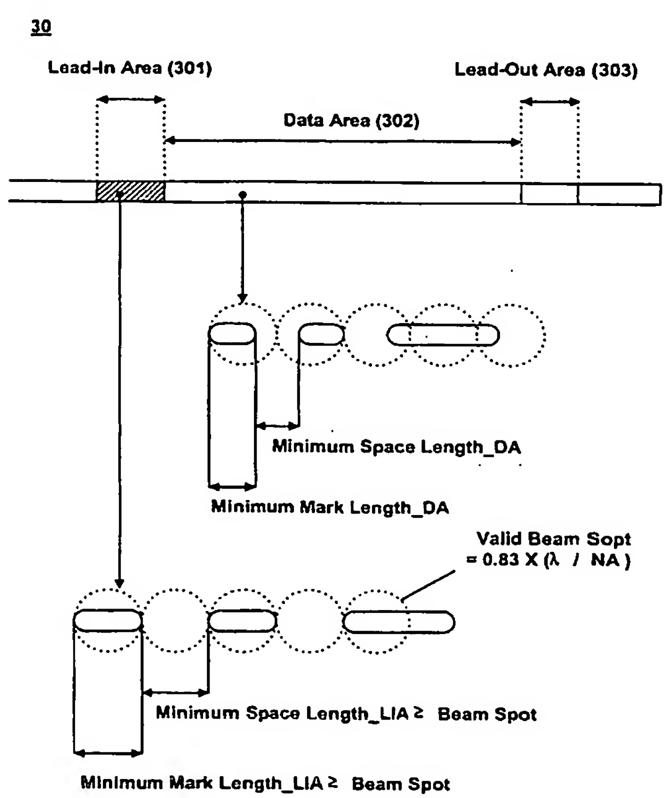
(54) Title: HIGH DENSITY OPTICAL DISC AND METHOD FOR REPRODUCING AND RECORDING DATA THEREOF



(57) Abstract: A high-density optical disc such as a high density-digital versatile disc (HD-DVD) or Blu-ray disc, and a method for reproducing or recording data of the high-density optical disc. The high-density optical disc includes a lead-in area, a data area and a lead-out area. The lead-in area has major information. A minimum mark or space length of the major information recorded in the lead-in area is longer than that of data recorded in the data area. The major information of the lead-in area is copied to the lead-out area. On the basis of the data reproduction or recording method, an optical disc device can correctly read and confirm the major information from the high-density optical disc, minimize the interference between a mark and space in high-density recording data, reduce the effects of scratches or dust on the disc, and efficiently prevent an erroneous data reproduction or recording operation.

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DESCRIPTION

HIGH DENSITY OPTICAL DISC AND METHOD FOR REPRODUCING AND RECORDING DATA THEREOF

1. Technical Field

The present invention relates to a high-density optical disc such as a high density-digital versatile disc (HD-DVD) or Blu-ray disc, which includes a lead-in area, data area and lead-out area.

2. Background Art

Fig. 1 is a view illustrating the structure of a conventional digital versatile disc (DVD). The DVD 10 has a thickness of 1.2 mm and a diameter of 120 mm. The DVD 10 includes a center hole having a diameter of 15 mm, and a clamping area having a diameter of 44 mm so that a turntable and clamper provided in an optical disc device can clamp the DVD 10.

A data recording layer based on a pit pattern is formed on the DVD 10. There is a distance of approximately 0.6 mm between the data recording layer and the surface of an optical transmission layer, which is arranged between the data recording layer and an objective lens (OL) of an optical pick-up provided in the optical disc device. The OL of the optical pick-up for the DVD has a numerical aperture (NA) value of 0.6.

As shown in Fig. 2, a high-density optical disc 20 such as a high density-digital versatile disc (HD-DVD) or Blu-ray disc has a thickness of 1.2 mm and a diameter of 120 mm. The high-density optical disc 20 includes a center hole having a diameter of 15 mm, and a clamping area having a diameter of 44 mm so that a turntable and clamper provided in an optical disc device can clamp the high-density optical disc 20. There is a distance of

approximately 0.1 mm between a data recording layer and the surface of an optical transmission layer, which is arranged between the data recording layer and an objective lens (OL) of an optical pick-up provided in the optical disc device.

The OL of the optical pick-up for the high-density optical disc has a relatively larger NA value of 0.85, in comparison with the OL of the optical pick-up for the general DVD. In order for high-density recording data to be reproduced or recorded, the high-density optical disc uses a laser beam having a relatively shorter wavelength in comparison with the general DVD. That is, a laser beam having a wavelength of 650 nm is used for the general DVD 10, while a laser beam having a wavelength of 405 nm is used for the high-density optical disc so that the high-density recording data can be reproduced or recorded.

Thus, in a state where the OL of the optical pick-up for the high-density optical disc is closer to the recording layer of the high-density optical disc, the optical disc device employs a laser beam having a relatively shorter wavelength, and enables an NA value for the OL to be increased, thereby forming a small beam spot of the laser beam, having an increased light intensity, on the high-density recording layer. Further, an optical transmission layer transmitting a laser beam having a short wavelength can be reduced. Hence, variations of the laser beam's properties and aberration occurrence can be minimized.

As shown in Fig. 3, the high-density disc includes a lead-in area 201, data area 202 and lead-out area 203. In the lead-in area, are recorded major information needed for recording or reproducing data of the high-density optical disc, e.g., information associated with a size of the disc, a disc structure, a data recording density, a data area allocation, etc.

Therefore, when the high-density optical disc 20 is inserted and seated within the optical disc device, the major information recorded in the lead-in area 201 is first read and confirmed. The

optical disc device refers to the major information and then performs a sequence of reproduction or recording operations for reproducing data recorded in the data area 202 or recording data in the data area 202.

In the lead-in area 201, data area 202 and lead-out area 203, a channel bit length and data bit length are 80.00 nm and 120 nm in the case of a 23.3 GB high-density optical disc, respectively. In the case of a 25 GB high-density optical disc, the channel bit length and data bit length are 74.5 nm and 111.75 nm, respectively. In the case of a 27 GB high-density optical disc, the channel bit length and data bit length are 69.00 nm and 103.50 nm, respectively. Minimum mark/space lengths of data recorded in the areas 201, 202 and 203 are the same as each other.

As described above, the optical disc device must first and correctly read and confirm the major information recorded in the lead-in area so that the data of the high-density optical disc is reproduced or recorded. At this time, the interference between a mark and space may occur in high-density recording data. Further, scratches or dust on the surface of the optical disc can adversely affect the recording and reproduction of high-density recording data. For this reason, there are problems in that the major information cannot be appropriately read and hence a data reproduction or recording operation cannot be appropriately performed.

3. Disclosure of Invention

Therefore, the present invention has been made in view of the above problems, and it is an object of the present invention to provide a high-density optical disc, and a method for reproducing or recording data thereof, which can allow an optical disc device to correctly read and confirm control information recorded in a lead-in area included in the high-density optical disc such as a high density-digital versatile disc (HD-DVD) or Blu-ray disc.

In accordance with one aspect of the present invention, the above and other objects can be accomplished by the provision of a high-density optical disc, comprising: a lead-in area; a data area; and a lead-out area, wherein a minimum mark or space length of data recorded in the lead-in area is longer than that of data recorded in the data area.

Preferably, in accordance with the high-density optical disc of the present invention, the minimum mark or space length of the data recorded in the lead-in area may be longer than that of the data recorded in the data area, and the minimum mark or space length of the data recorded in the lead-in area may be the same as or longer than a valid diameter of a laser beam spot.

Preferably, in accordance with the high-density optical disc of the present invention, the lead-out area may comprise at least one data item being the same as the data recorded in the lead-in area, and the minimum mark or space length of the data copied to the lead-out area may be the same as that of the data recorded in the lead-in area.

Preferably, where a minimum mark or space length of data recorded in the lead-in area is longer than that of data recorded in the data area in accordance with the high-density optical disc of the present invention, the high-density optical disc may further comprise a specified area in which information associated with the minimum mark or space of the data recorded in the lead-in area and data area is recorded.

In accordance with another aspect of the present invention, there is provided a method for reproducing or recording data of a high-density optical disc, comprising the steps of: (a) detecting a rotation velocity of a spindle motor in a procedure of reading data recorded in a lead-in area and comparing the detected rotation velocity with a predetermined reference rotation velocity; and (b) applying a reproduction processing algorithm to reproduce the data recorded in the lead-in area based

on the result of the step (a).

In accordance with another aspect of the present invention, there is provided a method for reproducing or recording data of a high-density optical disc, comprising the steps of: (a) reading the information items associated with the minimum mark or space lengths of the data recorded in a lead-in area and data area from the specified area and comparing the information items; and (b) applying a reproduction processing algorithm to reproduce the data recorded in the lead-in area based on the result of step (a).

In accordance with another aspect of the present invention, there is provided a method for recording information on an optical recording medium which includes lead-in area, user data area, and lead-out area, comprising the steps of: (a) recording, in the user data area, data to be recorded according to a control signal from controller; (b) recording, in lead-in area or lead-out area, first control information to control reproduction of the recorded data in the user data area; and (c) recording, in an area other than the lead-in, the lead-out, and the user data area, second control information to control reproduction of the recorded data in the lead-in or lead-out area, wherein the second control information is to indicate a minimum length of mark or space recorded in user data area and a minimum length of mark or space in the lead-in or lead-out area respectively.

In accordance with another aspect of the present invention, there is provided a method for recording information on an optical recording medium which includes lead-in area, user data area, and lead-out area, comprising the steps of: (a) recording, in the user data area, data to be recorded according to a control signal from controller; and (b) recording, in a specified area other than the user data area, control information to control reproduction of the recorded data in the user data area, wherein the control information includes information for indicating a minimum length of mark or space recorded in user data area and

a minimum length of mark or space in the lead-in or lead-out area respectively.

4. Brief Description of Drawings

The accompanying drawings, which are included to provide a further understanding of the invention, illustrate the preferred embodiments of the invention, and together with the description, serve to explain the principles of the present invention.

Fig. 1 is a view illustrating the structure of a conventional digital versatile disc (DVD);

Fig. 2 is a view illustrating the structure of a conventional high-density optical disc such as a high density-digital versatile disc (HD-DVD) or Blu-ray disc;

Fig. 3 is a view illustrating a lead-in area, data area and lead-out area provided in the conventional high-density optical disc;

Fig. 4 is a view illustrating a state where data having different minimum mark/space lengths are recorded in a lead-in area and data area provided in a high-density optical disc in accordance with the present invention;

Fig. 5 is a view illustrating a state where major information recorded in the lead-in area included in the high-density optical disc is copied to the lead-out area in accordance with the present invention;

Fig. 6 is a view illustrating a burst cutting area (BCA) of the conventional high-density optical disc;

Figs. 7(a) and 7(b) are views illustrating a data structure and data contents of BCA code for the conventional high-density optical disc;

Fig. 8 is a view illustrating a system for recording and reproducing data of the high-density optical disc in accordance with the present invention;

Fig. 9 is a flowchart illustrating a method for recording and reproducing the data of the high-density optical disc in

accordance with the first embodiment of the present invention; and

Fig. 10 is a flowchart illustrating a method for recording and reproducing the data of the high-density optical disc in accordance with the second embodiment of the present invention.

Features, elements, and aspects of the invention that are referenced by the same numerals in different figures represent the same, equivalent, or similar features, elements, or aspects in accordance with one or more embodiments.

5. Modes for Carrying out the Invention

Preferred embodiments of a high-density optical disc and a method for reproducing or recording data thereof in accordance with the present invention will be described in detail with reference to the annexed drawings.

Fig. 4 is a view illustrating a state where data having different minimum mark/space lengths are recorded in a lead-in area and data area provided in a high-density optical disc in accordance with the present invention. For example, a high-density optical disc 30 such as a high density-digital versatile disc (HD-DVD) or Blu-ray disc includes a lead-in area 301, data area 302 and lead-out area 303. In the lead-in area 301 are recorded major information needed for recording or reproducing data of the high-density optical disc, e.g., information associated with a size of the disc, a disc structure, a data recording density, a data area allocation, etc. A minimum mark/space length of the major information recorded in the lead-in area 301 is longer than that of general video and audio data recorded in the data area 302.

For example, as shown in Fig. 4, the minimum mark length (Minimum Mark_LIA) of the major information recorded in the lead-in area 301 is longer than the minimum mark length (Minimum Mark_DA) of the general video and audio data recorded in the data area 302. The length of a minimum mark recorded in the lead-in

area 301 is the same as or longer than a valid diameter of a beam spot depending upon the NA associated with an objective lens for the high-density optical disc and the wavelength λ of a laser beam.

As given by the following Equation 1, the valid diameter of the laser beam spot becomes approximately 395 nm where NA = 0.85 and λ = 405 nm (0.405 μm).

Equation 1

$$BeamSpot = 0.83 \times \frac{\lambda}{NA} = 0.83 \times \frac{0.405}{0.85} = 0.395\ \mu m = 395\ nm$$

In the above-described Equation 1, 0.83 is a coefficient, λ is the wavelength of a laser beam, and NA is a numerical aperture value.

Accordingly, the minimum mark length of the major information recorded in the lead-in area 301 is the same as or longer than the valid diameter 395 nm of the laser beam spot. Further, the minimum mark length of the major information recorded in the lead-in area 301 is longer than the minimum mark length of the video and audio data recorded in the data area 302. In this case, the minimum space length (Minimum Space_LIA) of the major information recorded in the lead-in area 301 is the same as or longer than the valid diameter 395 nm of the laser beam spot. The minimum space length of the major information recorded in the lead-in area 301 is longer than the minimum mark length (Minimum Space_DA) of the video and audio data recorded in the data area 302.

Referring to the table shown in Fig. 3, for example, the high-density optical disc can have three types of recording densities. The three types of recording densities based on a single layer include 23.305 Gbytes, 25.025 Gbytes and 27.020 Gbytes. A channel bit length corresponding to each recording

density, i.e., a length of "1T" is 80.00 nm in the case of 23.305 Gbytes. Further, the length of "1T" is 74.50 nm in the case of 25.025 Gbytes. Furthermore, the length of "1T" is 69.00 nm in the case of 27.020 Gbytes.

For example, where the recording density is 23.305 Gbytes, the valid diameter 395 nm of the beam spot produced by the above-described Equation 1 corresponds to a length of approximately 5T (395/80.00 = 4.9375 nm). A mark or space of data to be recorded in the data area has a length of "2T" to "8T". Thus, if the minimum mark or space length of data to be recorded in the lead-in area is the same as or longer than the valid diameter of the beam spot, a mark or space having a length of "5T" or more can be recorded as data of the lead-in area. In this case, a method for modulating data to be recorded in the lead-in area can be changed in order that a mark or space having a length of "5T" to "8T" or a length of "5T" to "11T" can be recorded. Further, in a state where the method for modulating data to be recorded in the lead-in area is the same as a method for modulating data to be recorded in the data area, the lengths of other marks or spaces can be increased in proportion to the increased minimum mark or space length.

First, since the lengths of other marks or spaces can be increased in proportion to the increased minimum mark or space length where the method for modulating data to be recorded in the lead-in area is the same as the method for modulating data to be recorded in the data area, a length of "2T" in the data area corresponds to a length of "5T" in the lead-in area, a length of "3T" in the data area corresponds to a length of "7.5T" in the lead-in area, and a length of "8T" in the data area corresponds to a length of "20T" in the lead-in area. Where the lengths of "5T" to "20T" are applied in place of the lengths of "2T" to "8T" as described above, there is a drawback in that the space of an embossed area may occupy much of the lead-in area. However, this

drawback does not need to be seriously considered since the embossed area conventionally has sufficient space for recording the disc-related major information. There is a merit in that a load of an optical disc system can be reduced where the same data modulation methods for the lead-in area and data area are used.

On the other hand, where the data modulation method for the lead-in area containing data of a mark or space having the minimum mark or space length of "5T" or longer is different from the data modulation method for the data area, for example, where the data in the lead-in area is modulated using marks or spaces based on only four types of "5T", "6T", "7T" and "8T" or using marks or spaces based on lengths of "5T" to "11T", there is a merit in that less of the space of the lead-in area is occupied. However, there is a drawback in that a new modulation method must be designed and a new reproduction device for performing a demodulation method corresponding to the new modulation method is additionally needed in the optical disc system.

As described above, where the minimum mark or space length of data recorded in the lead-in area is longer than that of data recorded in the data area or where disc data based on the different data modulation methods associated with the lead-in area and data area is reproduced or recorded, information associated with the lead-in area of the disc needs to be recognized so that the lead-in area containing information needed for reproducing or recording the disc data can be appropriately read. That is, when a minimum mark or space length of data or a data modulation type of the lead-in area is recognized, the data recorded in the lead-in area can be appropriately read.

The information associated with the lead-in area needs to be recorded in a specified area, formed inner than the lead-in area, to be first read when the disc is inserted in the optical disc device. As shown in Fig. 6, there is formed a burst cutting area (BCA) inner than the lead-in area. So it is preferable that

the information associated with the lead-in area is recorded in the BCA to be first read. The data recorded in the lead-in area can be appropriately reproduced using the information, associated with the lead-in area, recorded in the specified area as described above.

Further, Figs. 7A and 7B show a data structure and data contents associated with BCA code. For example, information indicating the minimum mark or space length of the lead-in area can be recorded in the 2nd data unit. Information indicating the minimum mark or space length of the data area can be recorded in the 3rd data unit. Information indicating a data modulation type for the lead-in area can be recorded in the 4th data unit. In this case, "b1b0" and "b7b6b5b4b3b2" of the 1st byte $I_{0,1}$ contained in the 2nd data unit can be "01" and "000010", respectively. The remaining 15 bytes contained in the 2nd data unit can be used for indicating the minimum mark or space length of the lead-in area. Similarly, "b1b0" and "b7b6b5b4b3b2" of the 1st byte $I_{0,2}$ contained in the 3rd data unit can be "10" and "000010", respectively. The remaining 15 bytes contained in the 3rd data unit can be used for indicating the minimum mark or space length of the data area. Similarly, "b1b0" and "b7b6b5b4b3b2" of the 1st byte $I_{0,3}$ contained in the 4th data unit can be "11" and "000010", respectively. The remaining 15 bytes contained in the 4th data unit can be used for indicating the data modulation type.

Fig. 8 is a view illustrating a system for recording and reproducing data of the high-density optical disc in accordance with the present invention.

The system includes a high-density optical disc 50; an optical pick-up 60 for picking up data from the optical disc 50 or recording on the optical disc 50; a radio frequency (RF) processor for shaping a waveform of data read by the optical pick-up 60; a digital signal processor (DSP) 70 for converting data reproduced by the RF processor in a digital manner to

demodulate the data at a time of reproducing the data or modulating data at a time of recording the data; a buffer memory 80 for temporarily storing the data; and a controller 90 for controlling the above-described components of the system. The DSP 70 can include a processor 71 for the data area based on a default demodulation and reproduction signal processing method appropriate for reproducing general data recorded in the data area of the high-density optical disc; and a processor 72 for the lead-in area based on another demodulation and reproduction signal processing method appropriate for reproducing data in a state where the minimum mark or space length of the lead-in area has been lengthened or the data of the lead-in area has been especially modulated.

When the optical disc 50 is loaded in the system and data of the optical disc 50 read by the optical pick-up 60 is inputted into the DSP 70 through the RF processor, the controller 90 preferably performs a control operation such that the demodulation and reproduction signal processing method appropriate for reproducing the data recorded in the lead-in area can be selected using information, associated with the lead-in area, recorded in the innermost area of the optical disc 50.

As the minimum mark/space length of the data recorded in the lead-in area is the same as or longer than the valid diameter of the laser beam spot, the optical disc device for reproducing or recording data of the high-density optical disc can more correctly read and confirm major information recorded in the lead-in area. Thus, the interference between a mark and space in the high-density recording data can be minimized, and the effects of scratches or dust can be reduced. For this reason, an erroneous data reproduction or recording operation can be effectively prevented.

In preparing for the case where the scratch or dust having a certain size or larger exists on the lead-in area of the

above-described high-density optical disc, the major information of the lead-in area can be copied to the lead-out area 403 as shown in Fig. 5.

Next, there will be described the method for reproducing or recording data of the high-density optical disc in a state where the minimum mark or space length of data of the lead-in area is longer than that of data of the data area.

When the disc is loaded, the general disc reproduction or recording device performs an operation of reading major information recorded in the lead-in area of the disc and storing the read information in a memory. As the disc reproduction or recording device rotates a spindle motor to maintain a constant user data bit rate, a constant linear velocity is maintained in the lead-in area, the data area, an inner area or an outer area.

Thus, where the mark or space length of data recorded in the lead-in area is the same as that of data recorded in the data area, a linear velocity associated with a disc rotation for reading the data of the lead-in area equals that associated with the disc rotation for reading the data of the data area. Thus, the rotation velocity of the spindle motor can be predicted when the lead-in area located within a predetermined radius of the optical disc is read.

However, if the mark or space length of the data recorded in the lead-in area is longer than that of the data recorded in the data area, as a linear velocity for maintaining the constant user data bit rate associated with the lead-in area is faster than that for maintaining the constant user data bit rate associated with the data area, the rotation velocity of the spindle motor for reading the data of the lead-in area becomes faster than the predicted rotation velocity.

Meanwhile, if a data density is high, i.e., the mark or space length is short or a distance between tracks is narrow, the beam spot resolution is degraded and the characteristic of an optical

transfer function is degraded, such that it is difficult for a signal read by the optical pick-up to be appropriately demodulated and reproduced. For this reason, a modulation method is changed or a demodulation method such as a partial response maximum likelihood (PRML) or Viterbi-related demodulation method used in a communication system is used in order that the read signal can be appropriately demodulated and reproduced.

The demodulation method for reproducing the read signal is applied for only processing data modulated by the corresponding modulation method. The above-described demodulation method cannot be applied where the data is modulated by a different modulation method or the characteristic of the optical transfer function is changed. Thus, where the mark or space length of the lead-in area is different from that of the data area, the characteristics of optical transfer functions associated with the lead-in area and data area are different. For this reason, different signal processing methods must be applied for the different areas when the read signal is demodulated and reproduced.

Fig. 9 is a flowchart illustrating a method for recording and reproducing the data of the high-density optical disc in accordance with the first embodiment of the present invention.

When the high-density optical disc is inserted and seated in an optical disc reproduction or recording device at step S10, the device detects the rotation velocity of a spindle motor while rotating the disc on the basis of a linear velocity for reading data recorded in the lead-in area at a user data bit rate at step S11.

The device compares the detected rotation velocity with a predetermined reference rotation velocity at step S12. Herein, the predetermined reference rotation velocity is the velocity needed in order for data in lead-in area the minimum mark or space length of which is same as that of data in data area to be read

at the user data bit rate. At this time, if the detected rotation velocity is higher than the reference rotation velocity, it is determined that the minimum mark or space length of data recorded in the lead-in area is longer than that of data recorded in the data area. The device reads the lead-in area using a new reproduction processing method to reproduce data of the lead-in area having the minimum mark or space being relatively longer at step S13. Then, the device determines whether data recorded in the lead-in area has been completely read at step S14. If the data recorded in the lead-in area has been completely read, the reproduction processing method is switched to a default reproduction processing method for reproducing data recorded in the data area and then performs a reproduction or recording operation at step S15.

Fig. 10 is a flowchart illustrating a method for recording and reproducing the data of the high-density optical disc in accordance with the second embodiment of the present invention.

When the high-density optical disc having a specified area in which information items associated with the minimum marks or spaces of a lead-in area and data area are recorded, is inserted and seated in an optical disc reproduction or recording device at step S20, the device reads the information items associated with the minimum mark or space lengths of the areas from the specified area of the optical disc at step S21. The device compares values of the information items at step S22. If the minimum mark or space length of the lead-in area is longer than that of the data area as a result of the comparison, the device reads the lead-in area using a new reproduction processing method for reproducing the data of the lead-in area having the minimum mark or space being relatively longer at step S23. The device determines whether the data recorded in the lead-in area has been completely read at step S24. If the data recorded in the lead-in area has been completely read, the device switches the

reproduction processing method to a default reproduction processing method for reproducing the data recorded in the data area, and performs a reproduction or recording operation at step S25.

The above-described two methods for reproducing and recording data of the high-density optical disc in accordance with the two embodiments of the present invention can selectively use a separate reproduction or demodulation method for reproducing the data recorded in the lead-in area and a default reproduction or demodulation method for reproducing the data recorded in the data area.

When the high-density optical disc 40 having the lead-in area and lead-out area in which the same major information is recorded, is inserted and seated in the optical disc reproduction or recording device, the device determines whether the major information is appropriately read in a procedure of first reading and confirming the major information recorded in the lead-in area 401. At this time, if the major information is not appropriately confirmed, the device moves an optical pick-up to the lead-out area 403 and then reads the major information copied to the lead-out area 403. In this procedure, the device determines whether the major information copied to the lead-out area 403 is appropriately read. If the major information copied to the lead-out area 403 is not appropriately read, the device determines that an error of a reproduction or recording operation for the inserted disc occurs. Then, the device terminates the operation. On the other hand, if the major information recorded in the lead-in or lead-out area is appropriately read, the device can appropriately perform a sequence of reproduction or recording operations for reading/reproducing or recording data of the data area 402.

The present invention has been described on the basis of the disc data reproduction. The present invention can be applied for

a method and device for recording, in the specified area, information needed for reproducing data recorded in the lead-in area or optically modulating a mark or space of the lead-in area having a minimum length different from a minimum mark or space length of the data area. In particular, the present invention can be easily applied for mastering equipment. That is, the present invention can be extended to a method for manufacturing a disc having a specified area in which identification information associated with a lead-in area is recorded so that the data of the lead-in area can be appropriately read in a state where the minimum mark or space length of data of the lead-in area is longer than that of data of the data area.

As apparent from the above description, the present invention provides a high-density optical disc and a method for reproducing or recording data thereof, which can allow an optical disc device to correctly read and confirm major information from the high-density optical disc, minimize the interference between a mark and space in high-density recording data, reduce the effects of scratches or dust on the disc, and efficiently prevent an erroneous data reproduction or recording operation.

Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

CLAIMS

1. A high-density optical disc, comprising:

a lead-in area;

a data area; and

a lead-out area,

wherein a minimum mark or space length of data recorded in the lead-in area is longer than that of data recorded in the data area.

2. The high-density optical disc as set forth in claim 1, wherein the minimum mark or space length of the data recorded in the lead-in area is the same as or longer than a valid diameter of a laser beam spot.

3. The high-density optical disc as set forth in claim 2, wherein the lead-out area comprises at least one data item being the same as the data recorded in the lead-in area.

4. The high-density optical disc as set forth in claim 3, wherein the minimum mark or space length of the data copied to the lead-out area is the same as that of the data recorded in the lead-in area.

5. The high-density optical disc as set forth in claim 1, further comprising:

a specified area in which information associated with the minimum mark or space of the data recorded in the lead-in area and data area is recorded.

6. The high-density optical disc as set forth in claim 5, wherein the specified area is a burst cutting area (BCA).

7. A method for reproducing or recording data of a high-density optical disc, comprising the steps of:

(a) detecting a rotation velocity of a spindle motor in a procedure of reading data recorded in a lead-in area and comparing the detected rotation velocity with a predetermined reference

rotation velocity; and

(b) applying a reproduction processing algorithm to reproduce the data recorded in the lead-in area based on the result of the step (a).

8. The method as set forth in claim 7, wherein the step (b) comprises the step of applying a new reproduction processing method to reproduce the data recorded in the lead-in area, if the detected rotation velocity is higher than the reference rotation velocity.

9. The method as set forth in claim 7, further comprising the step of:

(c) applying a default reproduction processing method to reproduce the data recorded in the data area, if the data recorded in the lead-in area has been completely read.

10. A method for reproducing or recording data of a high-density optical disc, comprising the steps of:

(a) reading the information items associated with the minimum mark or space lengths of the data recorded in a lead-in area and data area from the specified area and comparing the information items each other; and

(b) applying a reproduction processing algorithm to reproduce the data recorded in the lead-in area based on the result of step (a).

11. The method as set forth in claim 10, wherein the step (b) comprises the step of applying a new reproduction processing method to reproduce the data recorded in the lead-in area, if a minimum mark or space length of the data recorded in the lead-in area is longer than that of data recorded in the data area as a result of the comparison.

12. The method as set forth in claim 10, further comprising the step of:

(c) applying a default reproduction processing method to reproduce the data recorded in the data area, if the data recorded

in the lead-in area has been completely read.

13. The method as set forth in claim 10, wherein the specified area is a burst cutting area (BCA).

14. A method for recording information on an optical recording medium, which includes lead-in area, user data area, and lead-out area, comprising the steps of:

(a) recording, in the user data area, data to be recorded according to a control signal from controller;

(b) recording, in lead-in area or lead-out area, first control information to control reproduction of the data recorded in the user data area; and

(c) recording, in an area other than the lead-in, the lead-out, and the user data area, second control information to control reproduction of the data recorded in the lead-in or lead-out area, wherein the second control information is to indicate a minimum length of mark or space recorded in user data area and a minimum length of mark or space in the lead-in or lead-out area respectively.

15. A method for recording information on an optical recording medium, which includes lead-in area, user data area and lead-out area, comprising the steps of:

(a) recording, in the user data area, data to be recorded according to a control signal from controller; and

(b) recording, in a specified area other than the user data area, control information to control reproduction of the recorded data in the user data area, wherein the control information includes information for indicating a minimum length of mark or space recorded in user data area and a minimum length of mark or space in the lead-in or lead-out area respectively.

16. The method as set forth in claim 15, wherein the specified area is a burst cutting area (BCA) inner than lead-in area.

FIG. 1

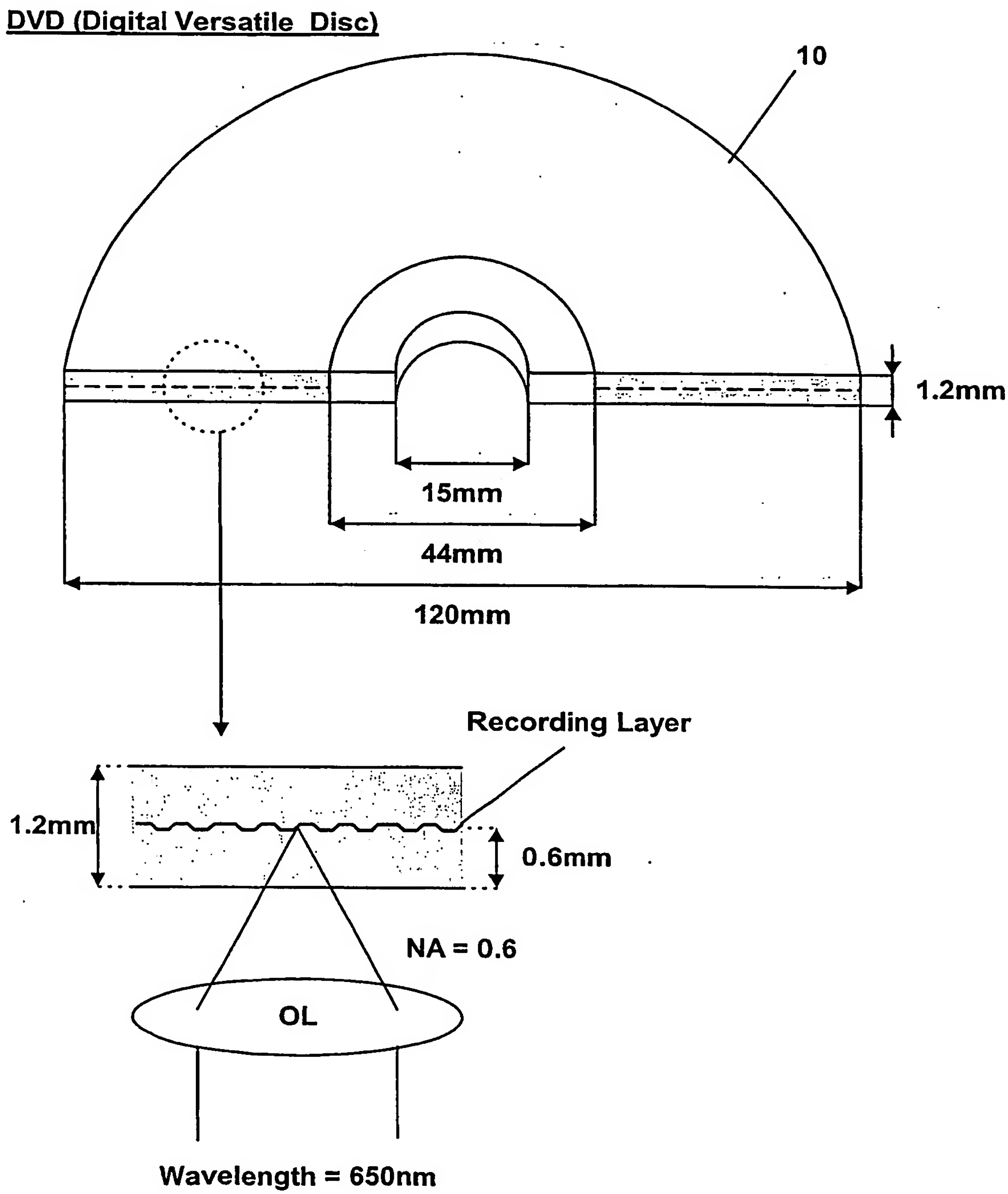

DVD (Digital Versatile Disc)
10
1.2mm
15mm
44mm
120mm
Recording Layer
1.2mm
0.6mm
NA = 0.6
OL
Wavelength = 650nm

FIG. 2

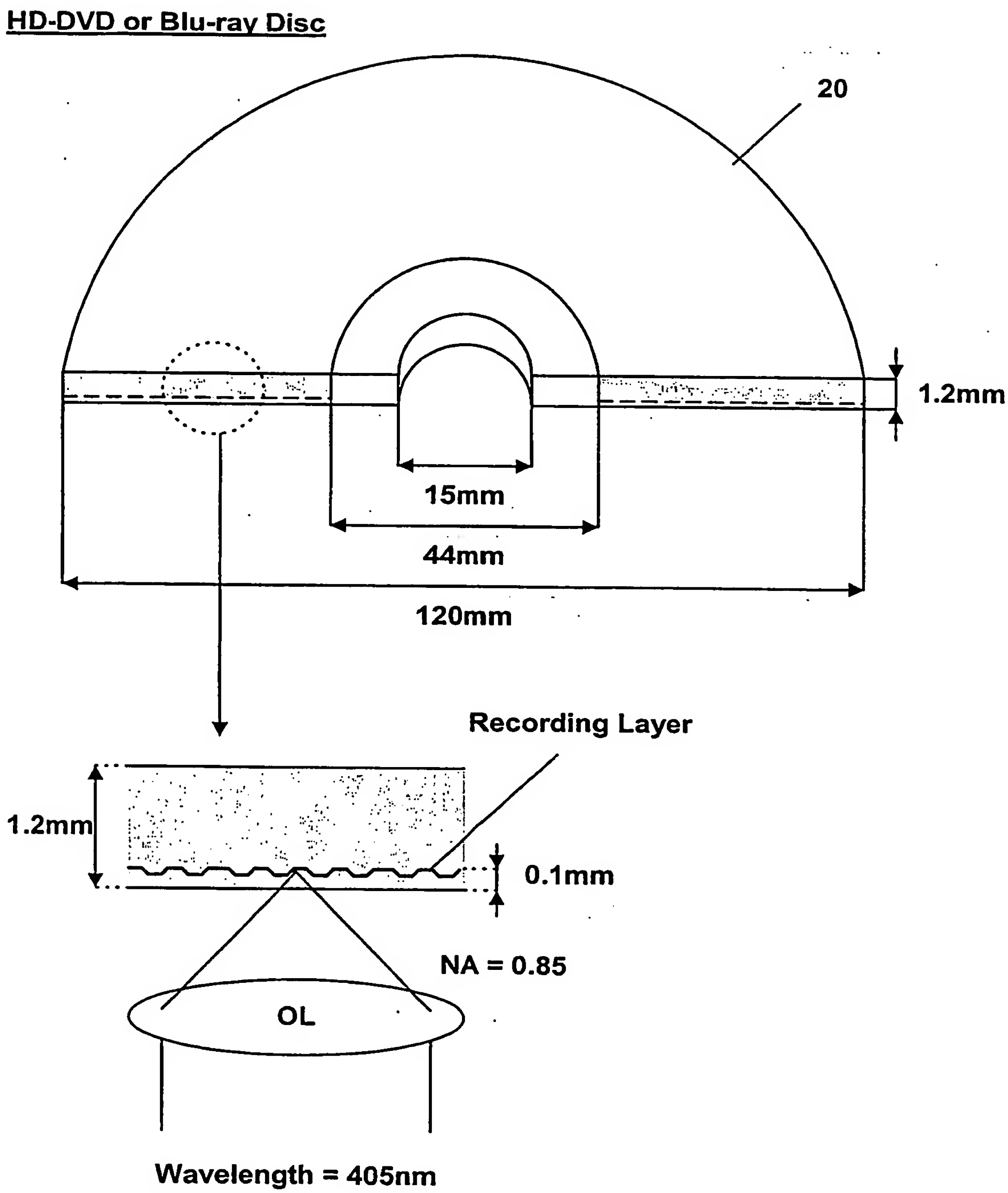
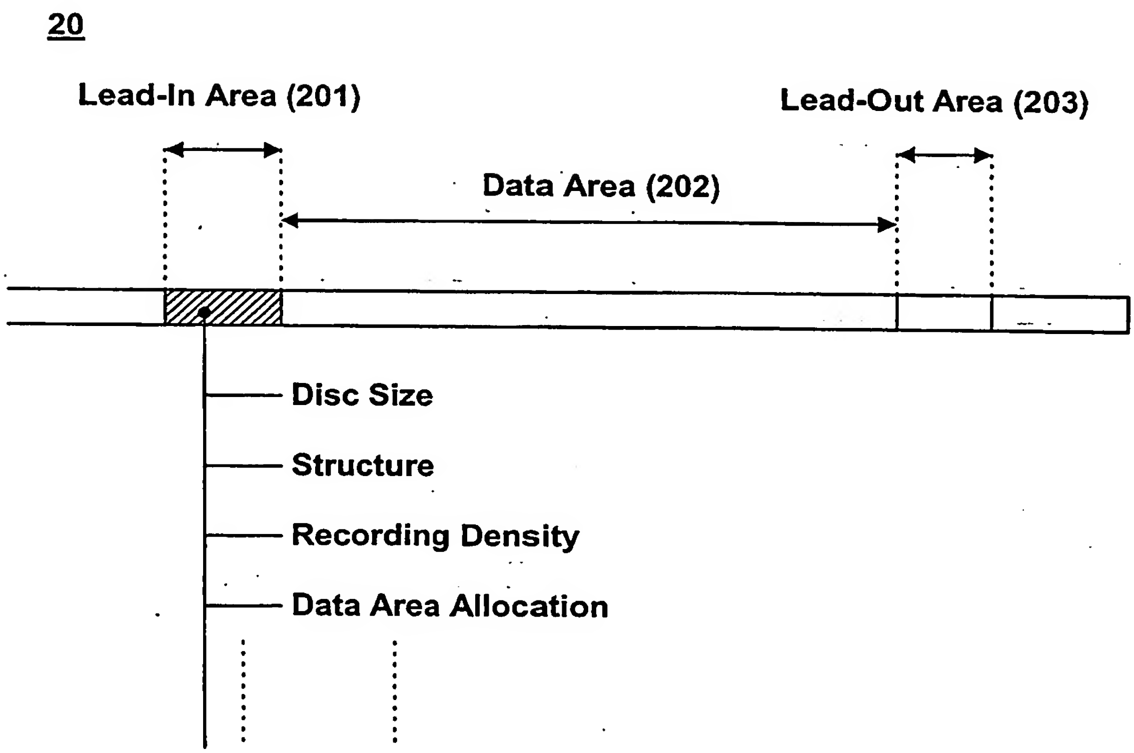

HD-DVD or Blu-ray Disc
20
1.2mm
15mm
44mm
120mm
Recording Layer
1.2mm
0.1mm
NA = 0.85
OL
Wavelength = 405nm

FIG. 3



Max User Data Capacity	23.3GB	25GB	27GB
Channel Bit length	80.00nm	74.5nm	69.00nm
Data Bit Length	120.00nm	111.75nm	103.50nm

FIG. 4

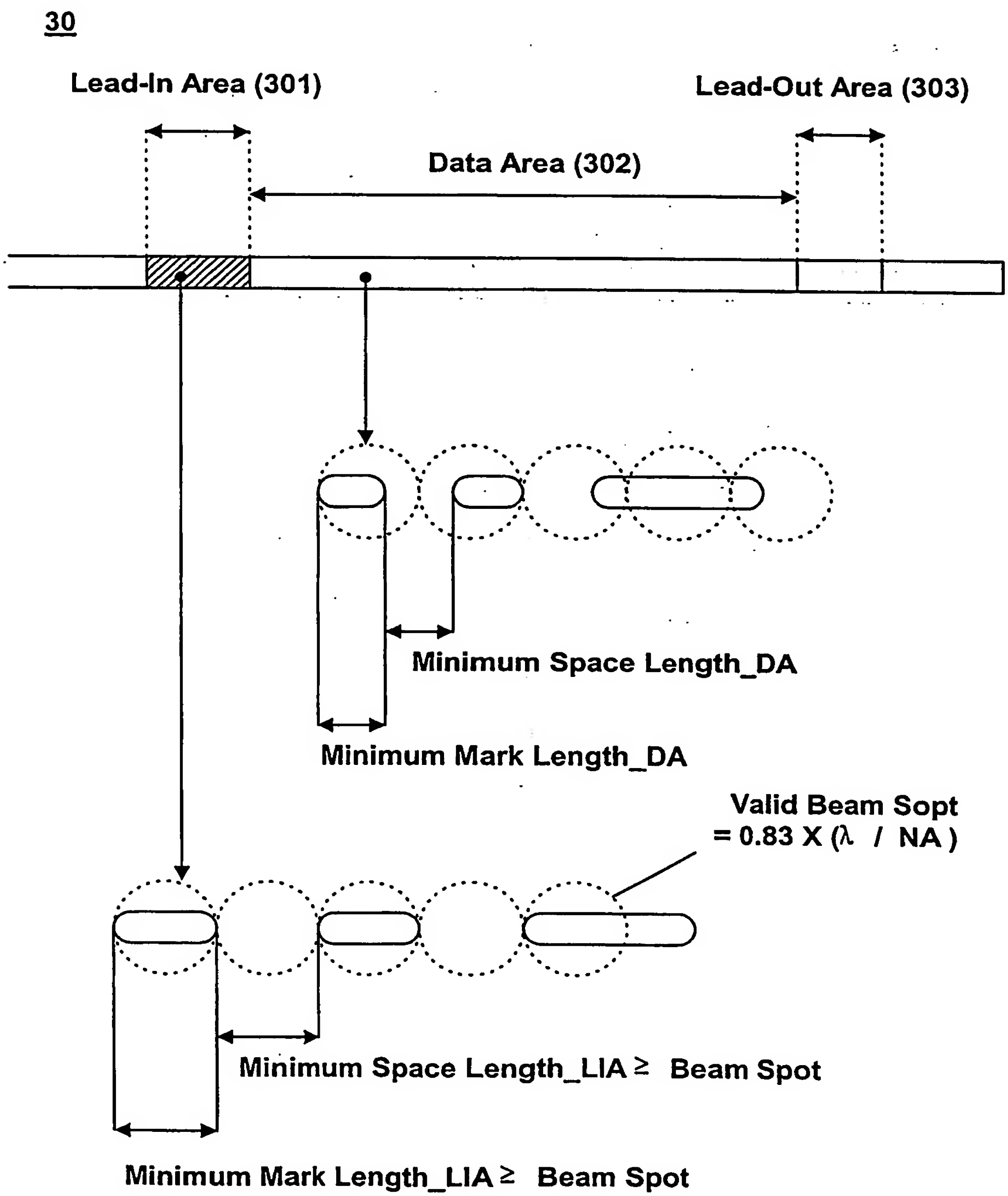

30
Lead-In Area (301)
Lead-Out Area (303)
Data Area (302)
Minimum Space Length_DA
Minimum Mark Length_DA
Valid Beam Sopt
= 0.83 X (λ / NA)
Minimum Space Length_LIA ≥ Beam Spot
Minimum Mark Length_LIA ≥ Beam Spot

FIG. 5

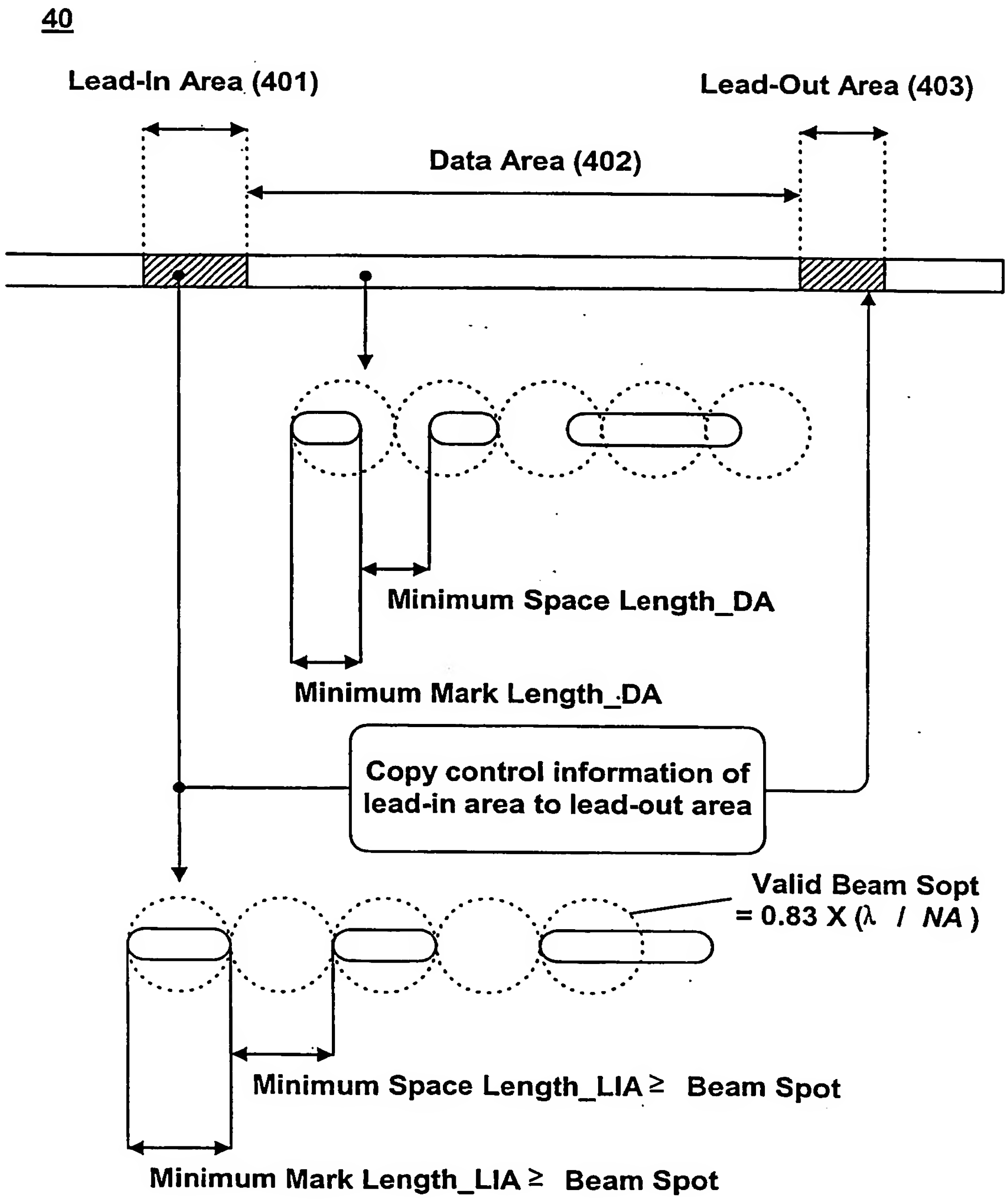

40
Lead-In Area (401)
Lead-Out Area (403)
Data Area (402)
Minimum Space Length_DA
Minimum Mark Length_DA
Copy control information of lead-in area to lead-out area
Valid Beam Sopt = 0.83 X (λ / NA)
Minimum Space Length_LIA ≥ Beam Spot
Minimum Mark Length_LIA ≥ Beam Spot

FIG. 6

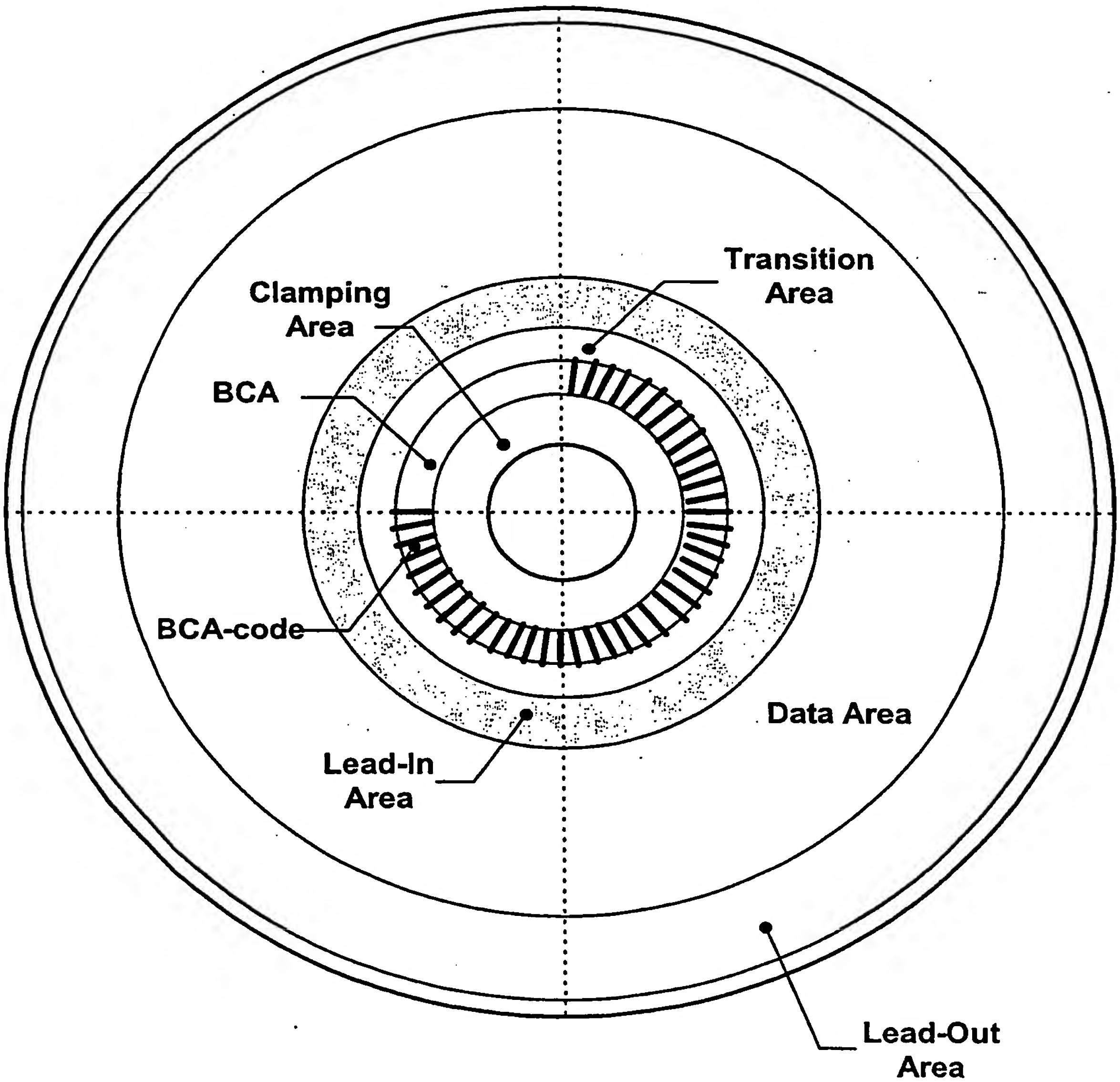

Transition Area
Clamping Area
BCA
BCA-code
Data Area
Lead-In Area
Lead-Out Area

FIG. 7(a)

Data sturcture of BCA-code

1 byte	4 bytes					
SB(3,3)	BCA pre-amble (all 00h)				1 row	
SB(0,0)	I(0,0)	I(1,0)	I(2,0)	I(3,0)	4 rows data	1st data unit
SB(0,0)	I(4,0)	I(5,0)	I(6,0)	I(7,0)		
SB(0,0)	I(8,0)	I(9,0)	I(10,0)	I(11,0)		
SB(0,0)	I(12,0)	I(13,0)	I(14,0)	I(15,0)		
SB(0,1)	C(0,0)	C(1,0)	C(2,0)	C(3,0)	4 rows parity	
SB(0,1)	C(4,0)	C(5,0)	C(6,0)	C(7,0)		
SB(0,1)	C(8,0)	C(9,0)	C(10,0)	C(11,0)		
SB(0,1)	C(12,0)	C(13,0)	C(14,0)	C(15,0)		
SB(0,2)	I(0,1)	I(1,1)	I(2,1)	I(3,1)	4 rows data	2nd data unit
SB(0,2)	I(4,1)	I(5,1)	I(6,1)	I(7,1)		
SB(0,2)	I(8,1)	I(9,1)	I(10,1)	I(11,1)		
SB(0,2)	I(12,1)	I(13,1)	I(14,1)	I(15,1)		
SB(0,3)	C(0,1)	C(1,1)	C(2,1)	C(3,1)	4 rows parity	
SB(0,3)	C(4,1)	C(5,1)	C(6,1)	C(7,1)		
SB(0,3)	C(8,1)	C(9,1)	C(10,1)	C(11,1)		
SB(0,3)	C(12,1)	C(13,1)	C(14,1)	C(15,1)		
SB(1,0)	I(0,2	I(1,2)	I(2,2)	I(3,2)	4 rows data	3rd data unit
SB(1,0)	I(4,2)	I(5,2)	I(6,2)	I(7,2)		
SB(1,0)	I(8,2)	I(9,2)	I(10,2)	I(11,2)		
SB(1,0)	I(12,2)	I(13,2)	I(14,2)	I(15,2)		
SB(1,1)	C(0,2)	C(1,2)	C(2,2)	C(3,2)	4 rows parity	
SB(1,1)	C(4,2)	C(5,2)	C(6,2)	C(7,2)		
SB(1,1)	C(8,2)	C(9,2)	C(10,2)	C(11,2)		
SB(1,1)	C(12,2)	C(13,2)	C(14,2)	C(15,2)		
SB(1,2)	I(0,3)	I(1,3)	I(2,3)	I(3,3)	4 rows data	4th data unit
SB(1,2)	I(4,3)	I(5,3)	I(6,3)	I(7,3)		
SB(1,2)	I(8,3)	I(9,3)	I(10,3)	I(11,3)		
SB(1,2)	I(12,3)	I(13,3)	I(14,3)	I(15,3)		
SB(1,3)	C(0,3)	C(1,3)	C(2,3)	C(3,3)	4 rows parity	
SB(1,3)	C(4,3)	C(5,3)	C(6,3)	C(7,3)		
SB(1,3)	C(8,3)	C(9,3)	C(10,3)	C(11,3)		
SB(1,3)	C(12,3)	C(13,3)	C(14,3)	C(15,3)		
SB(3,2)						

FIG. 7(b)

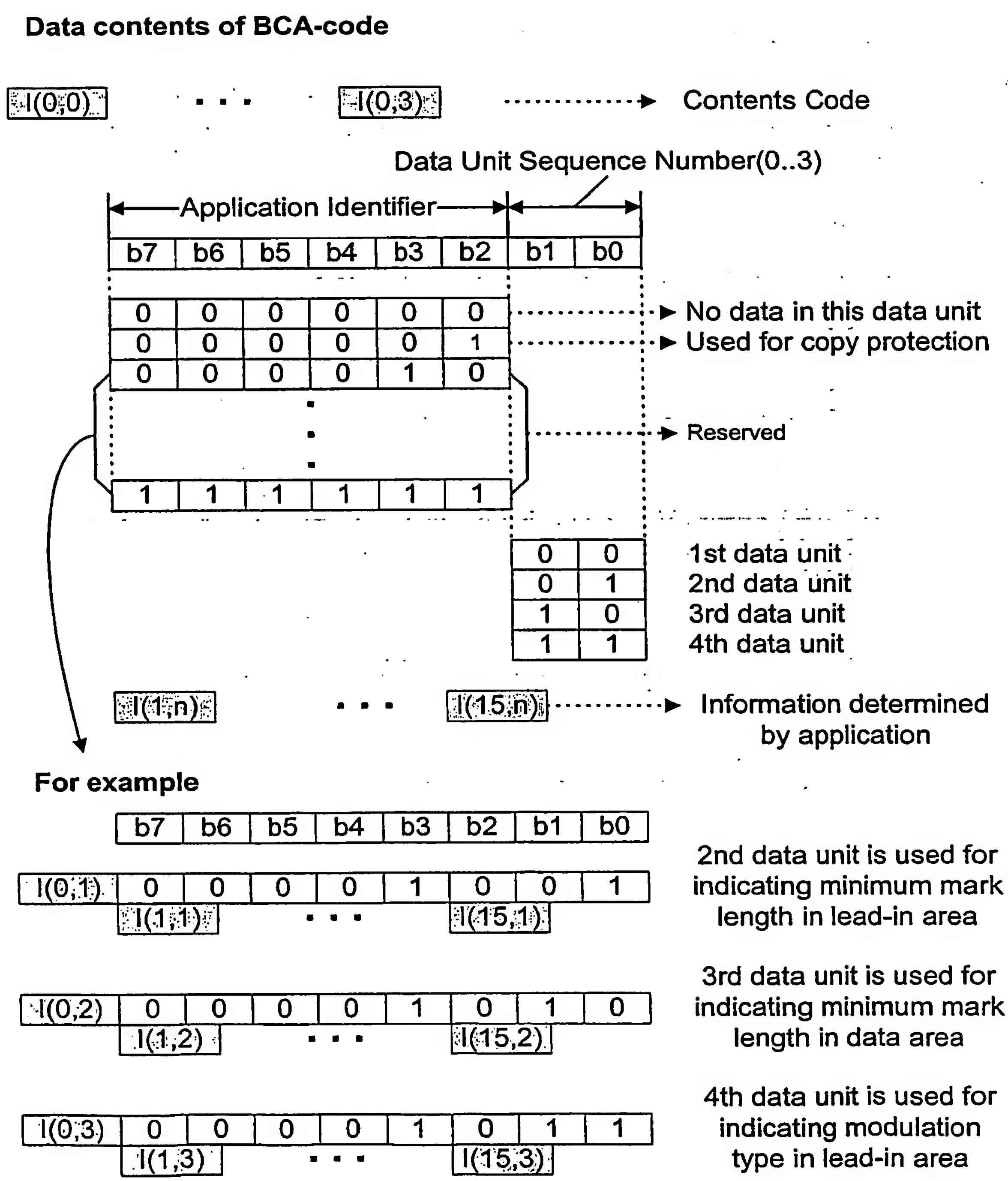

Data contents of BCA-code
I(0,0)
I(0,3)
Contents Code
Data Unit Sequence Number(0..3)
Application Identifier
b7 b6 b5 b4 b3 b2 b1 b0
0 0 0 0 0 0
0 0 0 0 0 1
0 0 0 0 1 0
1 1 1 1 1 1
No data in this data unit
Used for copy protection
Reserved
0 0
0 1
1 0
1 1
1st data unit
2nd data unit
3rd data unit
4th data unit
I(1,n)
I(15,n)
Information determined by application
For example
b7 b6 b5 b4 b3 b2 b1 b0
I(0,1) 0 0 0 0 1 0 0 1
I(1,1)
I(15,1)
2nd data unit is used for indicating minimum mark length in lead-in area
I(0,2) 0 0 0 0 1 0 1 0
I(1,2)
I(15,2)
3rd data unit is used for indicating minimum mark length in data area
I(0,3) 0 0 0 0 1 0 1 1
I(1,3)
I(15,3)
4th data unit is used for indicating modulation type in lead-in area

FIG. 8

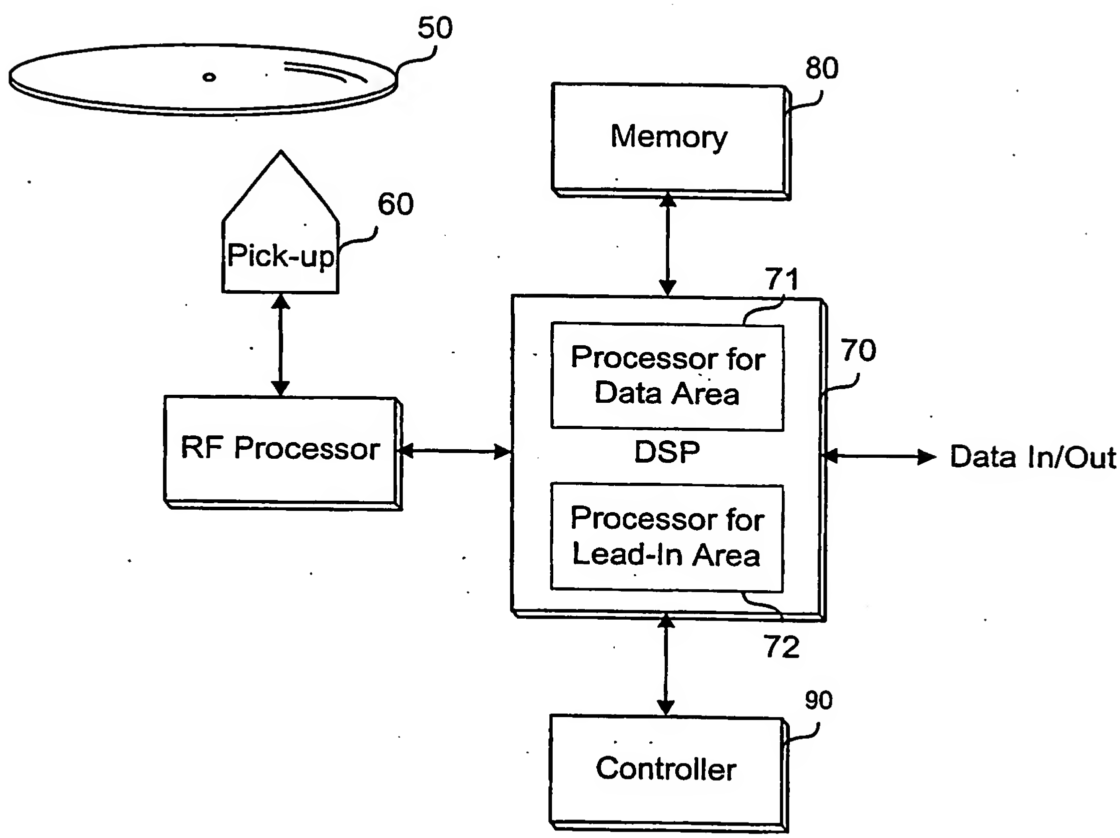

50
80
Memory
60
Pick-up
71
70
Processor for Data Area
RF Processor
DSP
Data In/Out
Processor for Lead-In Area
72
90
Controller

FIG. 9

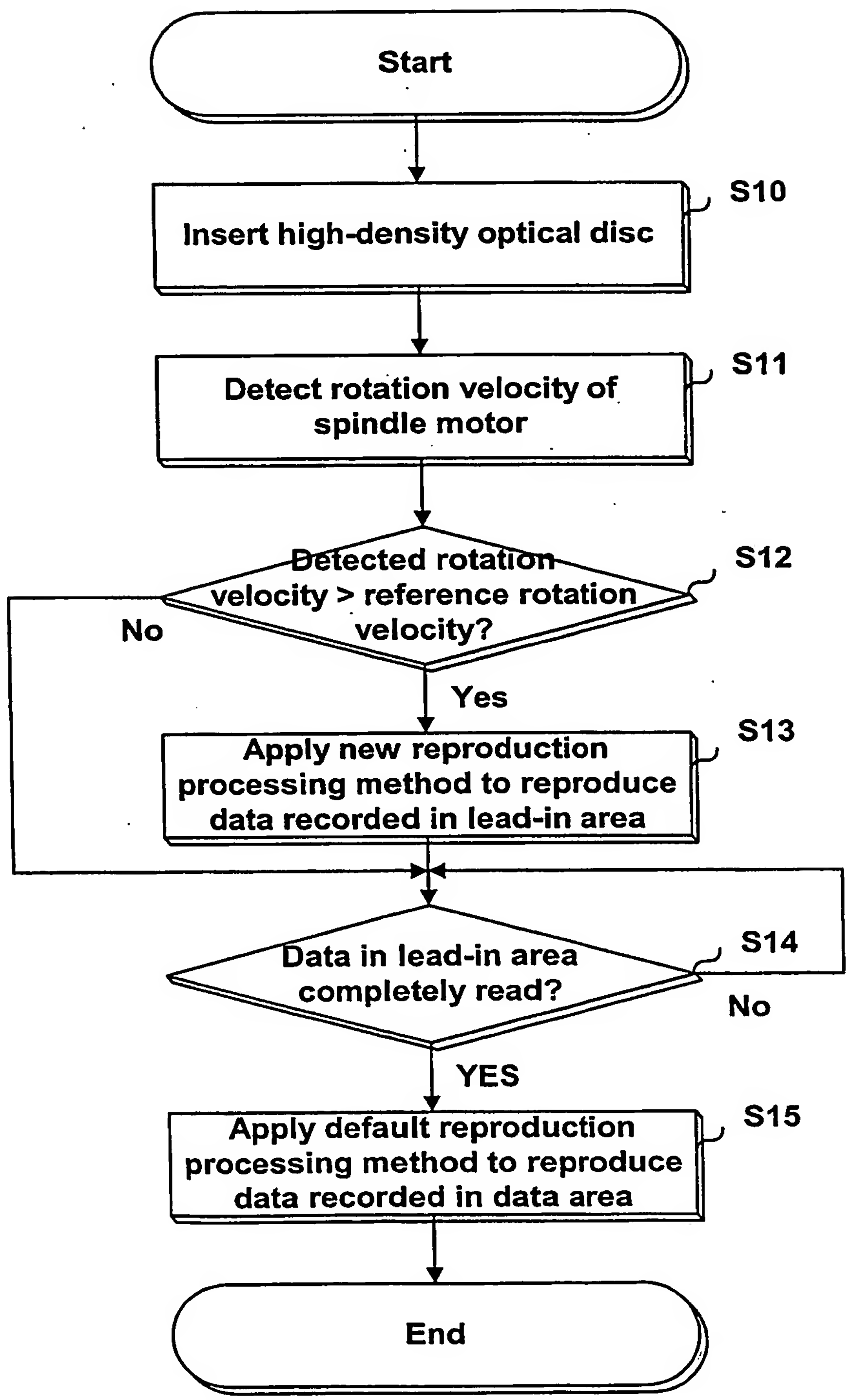
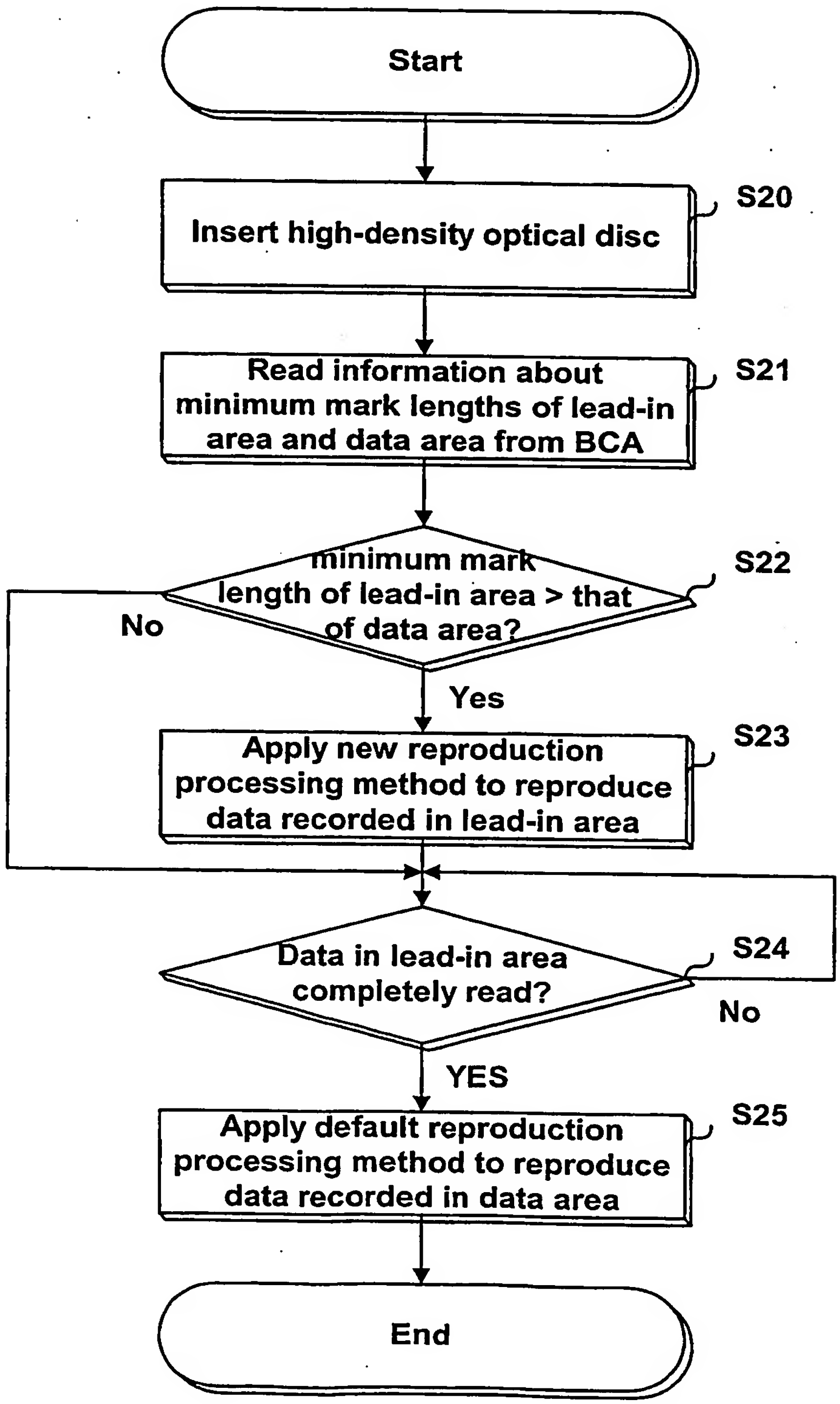

Start
S10
Insert high-density optical disc
S11
Detect rotation velocity of spindle motor
S12
Detected rotation velocity > reference rotation velocity?
No
Yes
S13
Apply new reproduction processing method to reproduce data recorded in lead-in area
S14
Data in lead-in area completely read?
No
YES
S15
Apply default reproduction processing method to reproduce data recorded in data area
End

FIG. 10


Start
Insert high-density optical disc
S20
Read information about minimum mark lengths of lead-in area and data area from BCA
S21
minimum mark length of lead-in area > that of data area?
S22
No
Yes
Apply new reproduction processing method to reproduce data recorded in lead-in area
S23
Data in lead-in area completely read?
S24
No
YES
Apply default reproduction processing method to reproduce data recorded in data area
S25
End